The Detection and Definition of an Industry: The English Medieval and Post Medieval Pin Industry.

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Although an industry can be defined as 'any branch of trade or manufacture', it is invariably associated with secondary definitions such as 'systematic economic activity' to refer to the production of large numbers of similarly manufactured and often identical items. This definition distinguishes industry from the more individualistic and irregular manufacture by 'craft'.

When industries from the period post 1600 AD are studied, it is invariably the written history of the manufacturing companies which are both the subject and result of the research into that industry. An example of such research is provided by the work of Hamilton (1967) and Donald (1955, 1961) who have derived a detailed picture of the commercial development of the 16th - 19th century British copper industry.

For the period prior to written records, industry has proved harder to define and study. Traditional archaeological references to industries usually refer to prehistoric bronze and flint objects, Medieval or Roman ceramics, all of which can be found in large numbers and are well represented in museum collections. They frequently have limited ranges of visual forms thus appearing to be the 'products' of an industrial process. Analysis of these archaeological objects either in terms of object form (Guido 1978), metric variation (Rowlands 1976) or elemental composition (Northover 1982) is often deemed to be related to influences on, or aspects of, the object's production 'industry'. Principal among these influences and aspects are:

i) industrial subdivisions such as particular workshops or craftsmen (Arhenius 1985)
ii) technical developments in manufacturing methods or final product properties (Tylecote and Gilmore 1986)
iii) influences of fashion such as romanisation
iv) variations in the raw material supply (Arhenius 1985)

The validity of the archaeological interpretation offered to explain the variations in any product parameter can rarely be independently validated. This is invariably due to the lack of any alternative c evidence, only further related product parameters are usually available. This confines much archaeological discussion to variations in personal interpretations of a single data set. There has been virtually no attempt to test our archaeological method by utilising the high and post medieval period, where we have an independent form of evidence available in terms of written history as well as extensive archaeological information. Thus in the context of industry there have been few, if any attempts to relate the archaeologically defined industry (in terms of a product typology, elemental composition or metrical analysis) to the written, post medieval histories of commercial industrial development. Can these different evidential forms identify and describe the same industry? If so do they tell the same story?

This paper attempts to examine the questions raised above, using the case of the medieval and post medieval copper alloy pin industry. The work is drawn from a doctoral thesis on the mediaeval English copper alloy pin industry, undertaken at Bradford University in the early 1980's (Caple 1986). The work was funded as a CASE award by S.E.R.C. in conjunction with English Heritage. This study extended earlier work by Tylecote (1972) and sought to examine the pin industry historically, typologically, metrically, and analytically.

The Archaeology of Medieval Copper Alloy Pins.

Copper alloy pins from early medieval contexts are rare. They were normally greater than 80mm in length, usually cast into shape as shown by those which have been examined metallographically (Caple forthcoming) and from the discovery of pin moulds from Dunadd (Lane 1980, 1981) and Helgo (Holmquist 1972). These pins are usually envisaged as being a fastening for a large garment such as a cloak. Virtually none of the pins recovered have been of identical form or size suggesting that these pins are of 'craft' manufacture. Large collections of these pins have been recovered archaeologically from the excavations in Coppergate, York (Caple forthcoming) and Dublin (O'Rahilly 1975).

The great majority of pins (99 %) from the high medieval and post medieval period are made of copper alloy (brass) wire. They are between 15 and 50 mm long, and have a head composed of a tightly wound spiral of wire (usually two turns) stuck or crimped onto the top of the shaft. These pins are formally referred to as wound wire headed pins (WWHP). Though they occur frequently on excavation they are rarely reported in detail. More extensive analysis has been undertaken in a limited number of cases (Tylecote 1972; Rahtz and Hirst 1976; Williams 1978; Caple 1983; Caple 1985) The earliest wound wire headed pins come from 13th and 14th century contexts at Southampton (Platt and Coleman Smith 1975). These pins are, however, only commonly seen in post 14th century dated contexts with many hundreds or thousands coming from 17th and 18th century dated urban domestic deposits. The large numbers of wound wire headed pins of very similar size and shape, together with the written description of pin manufacturing as the prime example of efficient manufacture by specialised workers for each separate manufacturing step (Smith 1776), has caused this object to be regarded as an industrial product. It is these medieval and post medieval wound wire headed pins, and their industry which is the subject of this paper.

The Written History of Pins and Pin Manufacture, 14th-19th Centuries.

Written descriptions or pictorial depictions of pin manufacture do not occur until the 18th century (Diderot 1771; Smith 1776). Prior to this the written sources record only the laws concerning the manufacture and sale of pins, records of imports and exports of pins, records of purchases or ownership of pins, and scant records of the pin makers' guilds.

These earlier written records do offer good evidence of the emergence of the wire pin industry in England during the 14th & 15th century. This is typified by the emergence of the trade of 'pinner' in York, where it is the occurrence of two pinners on the town council (the 'forty eight'), for the first time, in 1379 which indicates the establishment of this as a manufacturing trade in York by the late 14th century. The pin making craft appears not to have been present much earlier, since Bartlett (1958) indicates that there were no York freemen recorded as pinners in the tax returns for the period 1311 to 1341. References in the York Memorandum Book (Sellers 1911 and 1914) indicate that the ordinances (rules of a guild) for pinner's apprentices were being laid down from the period

of the 'Great Pestilence' of 1349 onwards suggesting a mid 14th century date for the emergence of the pinner's guild in York. A similar 14th century emergence of pinners is recorded in London with the occurrence of pinners on the town council (the 'forty eight') for 1376 (Longman and Lock 1911). In smaller towns such as Coventry it is the early 15th century, ie. 1435, before we have reference to a specific pin manufacturer, 'John Bayley pinner of Much Parke Street' (Harris 1907 - 1913)

The Pinners Guild of York expanded rapidly in the late 14th century with 12 pinners in the 1381 Lay Poll Tax Records (Bartlett 1958). The occurrence of 10 pinners living in a single parish 'Parochia Sancte Crucis' suggests that as with other trades there was a geographical concentration of pinners within a specific area of the city. The occurrence of twenty freemen of York as pinners by the period 1411-1441 indicates the level of the expansion of this trade (Bartlett 1959). Further evidence of the prominence of the Pinners Guild in York during the 15th century is provided by its contribution to the Mystery Play cycle, whilst in London the expanding pinners guild provided 20 men at arms to the City Watch. The records indicate that the guilds had the monopoly on making and selling pins in their towns, which they upheld by employing searchers to enforce guild standards on product production.

The burgeoning of the pin industry appears to have occurred to meet the need for pins in female fashion which was becoming far more intricate with frequent folds and tucks in garments of the 14th and 15th century. The written records often indicate women of status as being the customers of pinners eg the Duchess of Orleans, who in 1400, bought several thousand long and sharp pins from a pinner in Paris, Jehon de Areconmer (Longman and Lock 1911). Flemish painters of the 15th century eg Rogier van der Weyden, often depict pins in the garments of their female portraits, Plate 1.

By the mid 16th century the Pinners Guild appears to wain in importance, being merged with the Wiredrawers Guild in London in 1553, which was itself subsequently merged with the Girders Guild. In York the Pinners Guild was merged with that of the Wiredrawers in 1482/3 and after 1579 pinners are no longer represented on the town council (the 'forty eight').

The decline in the fortunes of the industry may coincide with records of the importation of pins into Britain from Europe. These begin as early as 1439/40, when the Venetian galley of Franciscus Dandolo landed a cargo including 44,000 pins at Southampton (Cobb 1961). This importation continued and expanded through the later 15th and early 16th century with extensive imports of pins by Rumbold Stry and Johanne Breamond recorded (Gras 1918). Import controls were attempted in the 15th century by Edward IV and subsequently by Richard III (Lipson 1956). Stronger measures were attempted in the 16th century by Henry VIII with edicts banning the sale of sub standard pins, a measure aimed at imported pins. Later in the century Elizabeth I specifically banned the importation of pins in an effort to protect the British pin producers (Longman and Lock 1911). These decrees appear to have had little effect, as the imports continued. This reflects the declining power of the guilds of pinners who were theoretically able to confiscate substandard pins particularly imports, but they appear to have been unable to afford the necessary scrutineers to protect their monopoly (Power and Postan 1933). The Pinners of London appealed to Lord Burghly (High Treasurer of England in late 16th century) to stop the importation of pins which they estimated were costing the country œ40,000 per annum. By the early 17th century further appeals to James I estimated the cost at œ60,000 per annum. Though it may be suggested that these sums were exaggerated to emphasise their political point, they appear to represent a continuing substantial level of imports. These appeals, however, had no effect in stemming the tide of imports, and the consequent decline in the manufacturing base of the English pin industry. The 17th century saw an increase in the number of grocers who acted as retail outlets for pins as well as many other small manufactured goods (Vaisey 1966; Lewis 1927), the Pinmakers Guild monopoly being apparently no longer even locally enforced.

The reason for the volume of cheap imports is unclear. It may represent differential labour costs between Europe and England or the early use of machines for pin production in continental Europe. In England during the 16th and 17th centuries there was considerable opposition to the use of machines, with the practice of mechanisation in the manufacture of needles being specifically banned in 1624 (Lipson E 1956) due to pressure from the Guild. Similar statutes for pin manufacture may have been applied. The first machines used to aid pinmaking in Britain are traditionally recorded as having been set up at Stroud, Gloucestershire in 1625/6 by a Bristol pinmaker John Tilsby (Longman and Lock 1911; Phillips 1839).

The manufacture of pins in Britain in the 17th century appears to have been restricted since in Britain the production of brass and its manufacture into wire (the raw material for pin manufacture), were monopolies of The Mines Royal Company and The Mineral and Battery Works Company (Nef 1934; Donald 1955, 1961; Alexander 1955; Hamilton 1967; Rees 1968). These companies which started the production of copper and brass and the manufacture of brass into saleable items, on a commercial scale in the late 16th and early 17th centuries were subject to considerable fluctuations of fortune, due to political interference, and shortage of capital during the 17th century. Attempts were made by several individuals such as Sir Thomas Bartlett, Mr Lydsey, and James I, to control the monopoly on brass wire production and force British pinmakers to buy solely from them. Though this might have generated a financially lucrative business for the individuals concerned, intermittent wire production, poor quality wire, and problems in enforcing the brass wire monopoly seem to have caused the business to fair poorly leading to consequent problems for the British pin industry (Caple 1986). This resulted in continued importation of pins from continental Europe, particularly during the Civil War, when few British industries flourished.

The removal of the monopolies on copper, brass and wire production in the 1690's saw the establishment of a number of separate companies in the Bristol and Mendip area, such as the Bristol Brass Company founded in 1702 (Day 1973), engaged in brass and wire manufacture. This created a resurgence of brass wire production and consequently of pin manufacture centred in the West Country during the 18th century. Pin production was concentrated in a number of semi-mechanised manufactories of the type described by Diderot (1771) and Smith (1776). The initial pin manufactories of Bristol and Gloucester which had been established purely due to the proximity of brass wire production were gradually replaced during the 19th century by manufactories based in the emerging towns of London, Birmingham and Warrington, since cheap labour costs had become the essential element in competitive production of cheap manufactured goods such as pins (Jones 1973; Caple 1986).

The details of the economic fortunes of the 18th & 19th century pin industry have been described elsewhere (Ashton 1925; Jones 1973). The manufacturing base was again changed as a result of the introduction of near total automation from the mid 19th century with the production of pins with 'upset' heads. Written records detailing the affairs of the companies producing pins in this machine based industry become frequent from the mid 19th century onwards.

From the earliest 14th and 15th century written records pins of different sizes were referred too by a variety of names (Longman and Lock 1911). By the 19th century there were not only names for different pins 'the smallest of which are called minikins' (Head 1836) but more commonly numerical references. These numbers refer to the 'size' of the pin which presumably refers to the pin length. British pin sizes range from 3 to 20 (Head 1836) and clearly indicate a level of standardisation in the pin industry by the early 19th century. A reference by Babbage (1835) equating British number 'elevens' to the French number 'sixes', indicates different numerical standards were being used by different countries. It is not yet known how early numerical standardisation was introduced but even in the medieval period a pin's length was one of the specific parameters checked by the searchers of the pinmakers guilds. There are no indications of the margin of error permitted for any of the size/length standards being used, nor any indication of how long any of the various standards were enforced. Clearly the importation of pins with different length standards, the use of old pins as well as new and the variations of pin length actually permitted within any given standard, will have resulted in a wide distribution of pin lengths in use at any one time.

Typological and Metrical Appraisal of Pins 14th-19th Century.

The large numbers of medieval wound wire headed copper alloy pins are invariably regarded archaeologically as an industrial product. It is the very regularity of form which is responsible for this classification, the minor variations of form or other parameter associated with individualistic craft production are presumed to have been suppressed. Any changes in the form or nature of this industrial product, are likely to represent a change on the industrial scale eg. new styles demanded by the consumer, or a change in raw material supply or manufacturing method. A major programme of typological and metrical analysis should thus reveal these variations and thus point to significant changes in the industry and its product.

Earlier work (Caple & Warren 1983) established that there are three major head form variants for wound wire headed pins, Figure 1.

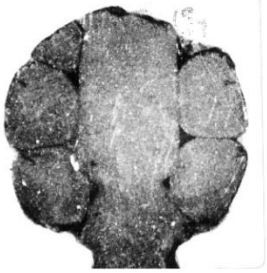
A - 2 twists of wire stuck onto the top of the shaft with a flux or adhesive
B - 2 twists of wire loosely crimped onto the top of the shaft
C - 2 twists of wire tightly crimped onto the top of the shaft forming a spherical head

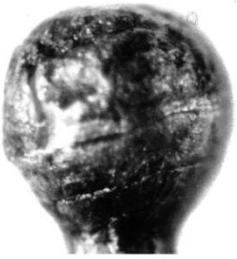
External view of the pinhead

Metallographic cross section of the pinhead

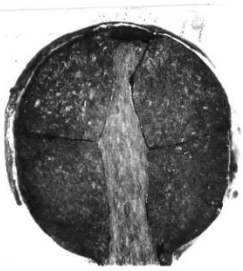
Type A wound wire headed pin. The spiral head wire is attached to the shaft by means of a black vitreoous paste.

Type B wound wire headed pin. The spiral wire has been partially compressed to grip the shaft. traces of balck vitreous paste are alos sometimes present.





Type C wound wire headed pin. The spiral head wire has been severely compressed onto the shaft between a pair of hemispherical hollowed punches to form a sperical head.



A further 14 types of wound wire head form have been identified (Caple 1986). These are represented by only a few examples from any site, the vast majority of pins having A, B or C type heads. In the case of Moulsham St, Chelmsford, 393 out of 448 identified wound wire headed pins had A, B, or C type heads. Analysis of the distribution of the common A, B and C type head forms with the date of the context from which they were recovered has been undertaken for pins from a number of sites, Table 1.

TABLE 1 : Distribution of the percentage of major wound wire headed pin head types from dated contexts.

Site and date:	A	B	C		Reference.
Moulsham St. Chelmsford.					Caple 1985
1560-1590	41	29	29		
1590-1630	24	28	31		
1630-1670	8	29	63		
1700-1730	19	34	47		
Whitefriars Church, Coventry.					Caple 1982
1548-1558	32	57	10		
Ludgershall Castle.					Caple 1986
1200-1500	70	30	0		
1500-1800	44	44	11		
Sandal Castle.					Caple 1983
pre 1484	57	36	7		
post 1484	45	10	45		
St. Peters St., Northampton.					Williams 1978
1400-1500	89		11	*	
1500-1800	49		41	*	
Exeter.					Goodall 1984
1450-1500	85		15	*	
1500-1550	96		4	*	
1550-1600	52		48	*	
1650-1700	12		88	*	
1700-1750	10		90	*	

* classification into A and C type heads only.

A large percentage of 'A' type heads are seen in the 15th century, with 'B' type heads becoming prevalent in the 16th century whilst 'C' type heads become dominant after 1700. Thus there is a discernible change in the form of the wound wire pinhead over time. This appears related to the method of head manufacture (Caple and Warren 1983) with the more securely fastened 'B' and ultimately 'C' type heads becoming more prevalent during the later periods.

The dimensions of the pin, in particular its length which is one of the most easily determined pin parameters is, like the head type, a variable which would be readily influenced by differing manufacturing regimes of the product.

For any site of any given period there are a range of lengths of pin e.g. Whitefriars Church, Coventry (1545-1558 AD), Figure 2. The overall distribution indicates that pins of between 20 and 32 mm were the most commonly utilised at this period. A number of pin lengths appear unusually well represented, standing above the general distribution. In this instance pin lengths of; 20mm, 25mm, 27/28mm, 30mm, 32mm, 34/35mm, 41mm, and 44mm appear as peaks in the distribution. These may represent specific pin sizes made at the time, with slight variations in length during the manufacturing process leading to a gaussian distribution of lengths around the specific size aimed for. It is the overlap of these distributions of the various sizes of pin which gives rise to the general distribution. Large numbers of pins, 200 plus, need to be measured per context to establish this sort of distribution and in only a few cases have such distributions been assembled (Caple 1986). The acquisition of further such distributions would allow us to determine the range of pin sizes prevalent at various dates. It will be interesting to study how the date, function of the site, and source of pin supply affect the range of pin sizes recovered from any site. With sufficient well dated examples, pin length distributions could become a useful diagnostic tool for factors such as the date or function of a site. There are a number of obvious complicating factors which will have a distorting effect on such distributions these include the use of both 'old' and 'new' pins by any one depositor, the construction of distributions from a small number of pins, the problems of ensuring an uncontaminated context when dealing with a small mobile item like a pin, together with the perennial problem of secure dating for archaeological deposits. The problems of trying this type of analysis with limited data was demonstrated by Frost and Windsor (1976) in their unsuccessful attempt to relate 19th century pin shaft diameters to common wire gauges of the period.

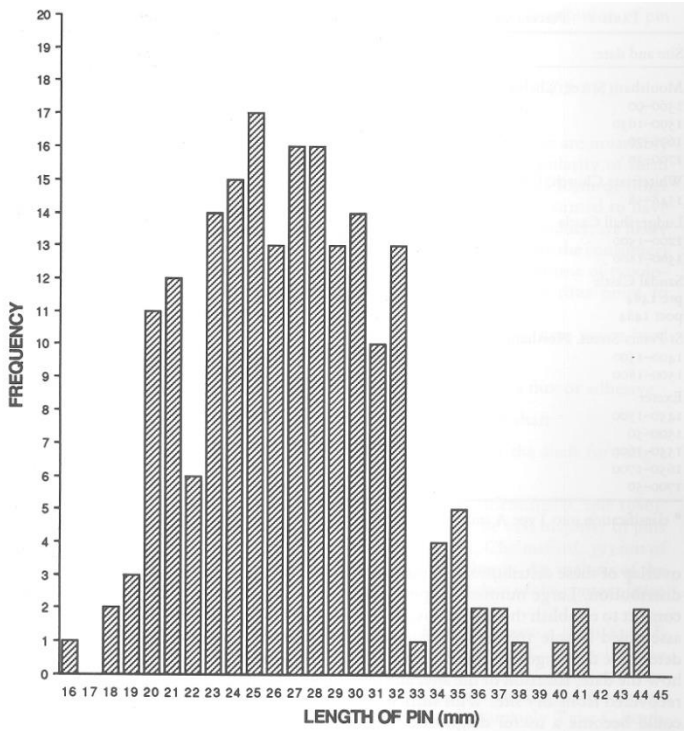


Figure 2: Distribution of the lengths of pins from Whitefriars Church, Coventry

Where smaller numbers of pins are encountered it has been noted that the overall distribution of pin lengths, is fairly similar for all sites of all periods, and thus the use of a single parameter, the mean,

to describe these distributions allows a general trend in the lengths of pins through time to be observed (Caple 1986). Analysis of the distribution of pin lengths and shaft diameters with the date of the context from which they were recovered has been undertaken for pins from a number of sites, Table 2.

TABLE 2: Distribution of the mean pin length and shaft diameter of wound wire headed pins from dated contexts.

Site and date	Mean pin length (mm)	Sample size	Mean shaft diameter (mm)	Sample size
St. Peters St., Northampton.				
1400-1500	47.8	50		
1500-1800	29.1	37		
Sandal Castle.				
pre 1484	43.4	35	0.964	47
post 1484	35.7	35	0.956	57
Whitefriars Church, Coventry.				
1545-1558	27.4	198	0.873	198
Ludgershall Castle.				
1200-1500	39.3	8		
1500-1800	34.8	8		
Moulsham St., Chelmsford.				
1560-1590	32.5	40	1.025	49
1590-1630	29.4	98	0.947	160
1630-1670	27.9	50	0.918	68
1700-1730	28.0	146	0.925	237
Eastgate, Gloucester. *				
1630-1670	0.815	10		
1670-1720	0.72	4		
1700-1710	0.759	22		

* pins from the Eastgate site in Gloucester reported by Frost & Windsor (1976) appear to have been measured on a different basis to all other diameter measurements reported here.

A consistent picture emerges from these results, in which the pre 1500 pins have mean pin lengths over 40mm. The distributions of pin length show that this occurs because of the prevalence of pins 40-50mm in length at this date. The pins of the period 1500 to 1630 are generally slightly shorter, with mean pin lengths of 29 to 35 mm. The pin length distributions show that this is a result of the

absence of the longer 40-50 mm pins, and consequently a prevalence of shorter 20-40mm length pins. The later period 1630 to 1730 saw pins which were generally even shorter, with means in the range of 25 to 30 mm. Thus a trend of shortening pins from the high to post medieval period can be discerned, though the different date ranges and the occasionally low numbers of pins involved in the present data set often prevent numbers being statistically significant and hence prevent 'significance' testing between pin length distributions.

The change in pin length is a gradual one with no sudden influx of short pins detectable. This gradual change may have resulted from a number of possible causes; the increasing fineness of cloth during this period or a change in fashion to have less visible pins and smaller folds and pleats in garments.

The analysis of a second metric parameter, shaft diameter, Table 2, indicates that there is a general diminution of the shaft wire diameter of the pins through the high, later and post medieval periods. Again this is not statistically provable, due to different date ranges and low numbers of examples in the present data sets. The change is again gradual, and presumably represents the increasing fineness of wire used in pin production. The correspondence in the decline in the length and shaft diameter of the pin is demonstrated by a restricted range in the shaft diameter to length ratios of 1:21 to 1:57 which are seen for all but one of the 700 plus pins and pinshafts from Moulsham St., Chelmsford (Caple 1986). The shorter the pin the thinner the wire used for its production or vice versa. Whether the causative mechanism for this change was improving technology (water and steam power and increased mechanisation) and consequently improvements in the technology and economics of fine wire production, giving rise to increasing supplies of fine wire products such as pins, or a customer driven demand for shorter finer pins, is currently unresolvable.

In addition to the parameters recorded above a wide range of other metrical and typological factors have been examined. Caple (1986) examined 22 separate visual and metrical aspects of wound wire headed pins. These included the cross section of the pinhead, the occurrence of tin coating on the pins and the presence or absence of specific manufacturing marks on the head and shaft. Typical of these parameters was the direction in which the head wire of the pin had been wound. The pins from Moulsham St. showed that head wires of 'A' type wound wire headed pins were wound principally anti-clockwise (Z twisted) but 12% were wound clockwise (S twisted). The 'B' and 'C' type wound wire heads, however, had 100 % wound anti-clockwise. This suggests variability in the manufacture of 'A' type wound wire heads which is consistent with being a handmade craft product. The regularity of 'B' and 'C' type headed pins is consistent with a mechanised manufactured product. This observation is supported by many of the other visual and metrical aspects of the pin, in particular marks of manufacture consistent with the use of pin making machines such as those illustrated by Diderot (1771) were visible on wound wire headed pins of 'B' and 'C' type but absent from 'A' type. It is interesting to note that 'C' type wound wire headed pins become predominant in deposits dated later than the mid 17th century, the date after which mechanised production of pins is believed to have started in England.

It has not been possible to isolate any, metrical or typological factor which can distinguish between British and imported pins. The increased numbers of 'C' type headed pins during the 17th century coincides with the increased levels of imports according to the written record. This pinhead type is, however, also the major product form of the burgeoning 18th century British pin industry.

Metal Composition of Pins and Wires, 14th - 19th Century.

Variations of the source of the raw material or in the processes carried out on a material during manufacture are frequently reflected in the variation of the elemental composition of the product. Energy dispersive X Ray fluorescence analysis (EDXRF) of hundreds of medieval wound wire headed pins and associated wires (Caple and Warren 1983; Caple 1986), indicated that the vast majority of such pins were made of brass containing low levels of lead occasionally a small percentage of tin was also present. Where small numbers of pins were analysed from a single site, the elemental variation between pins within a dated phase was little different from that seen between the various phases of the site eg Moulsham St., Chelmsford (Caple and Warren 1983). This suggests that for the post medieval period a wide range of elemental variation within the alloy was tolerated for pin production. Typical compositions of; copper 66 - 83 %, zinc 15 - 31%, lead 0 - 5% were seen in the pins from Moulsham St (1560-1730). Analyses of copper alloy wires of this period show exactly the same range of compositions as those used for pins. These alloys are also similar to those used for some of the few sheet and wrought metal analyses obtained for this period (Caple 1986a). Analysis of pins and wires from numerous sites throughout the country showed a wide variation in composition, however, if the mean values of the alloy constituents are examined, Table 3, a clear consistent overall change in composition is discernible for the two elements, zinc and tin (Caple 1986).

TABLE 3

DATE Century	Mean Zinc Content	Mean Tin Content	Number of Samples
14th	17.3	1.6	36
15th	18.1	0.9	14
16th	20.9	0.5	69
17th	23.2	0.2	31
18th	23.5	0.3	29
19th	24.6	0.1	31

During the high to post mediaeval period there is a change from a medium zinc brass with a low level of lead and a small percentage of tin present to a high zinc brass with a low level of lead and virtually no tin present. Similar developments in the composition of copper alloys have been noted for memorial brasses (Cameron 1974) and jettons (Pollard 1983). It would thus appear to be the general metal supply which is changing and not specifically the metal used in the manufacture of wires and pins. The gradual change in composition with no sudden alteration at any one single date suggests a good continuity of metal supply throughout this period.

No elemental differences were detected which could have been related to differences between British and imported pins. One would not be expected since throughout the High and Later Medieval periods Britain imported its copper alloy principally from Europe and thus British and imported European pins would have been made from the same raw material.

It is interesting to note that though there are a wide variety of copper alloy compositions used for cast objects (Brownsword pers comm) the great majority of the large, often cast objects from throughout Europe analysed by Werner (1977) have similar zinc and tin levels to the copper alloys used for pins and wires. The only significant difference was the addition of large percentages of lead to the casting alloys.

Occasionally some distinct alloy compositions are detected in the alloys used in pin manufacture eg. a low zinc brass with minor amounts of arsenic and nickel. This metal is seen principally in the pins from Sandal Castle (Caple 1983), though it is also detected at sites such as Moulsham St. Chelmsford, Whitefriars Church Coventry and Salisbury. This alloy is probably the product of a particular copper alloy manufacturing source operating in the 15th and 16th century. The presence of arsenic and nickel in the copper limited the take up of zinc vapours during the cementation process of brass manufacture (Craddock 1978), thus giving rise to the lower than usual zinc content of these particular brasses. The source of the arsenic and nickel rich copper has not yet been determined.

The major change in pin form, i.e. head type, is seen to correlate with changes in their elemental composition, Table 4.

TABLE 4

Alloy Composition of Wound Wire Headed Pins from a range of sites, from Caple 1986

	Zinc %		Tin %		Lead %		Number
	Mean	SD	Mean	SD	Mean	SD	of pins
Head Type							
A	19.3	5.6	0.47	1.38	2.6	2.1	55
B	21.6	5.2	0.49	1.27	1.98	1.58	73
C	27.2	3.7	0.2	0.68	2.34	1.80	34

The range of compositions of the metal used in the manufacture of pins, is reflected in the large standard deviation (SD) of the alloying elements. The most distinctive correlation is the high level of zinc seen in pins with 'C' type heads. The increasing percentage of zinc noted by Table 3 can thus be related to the increasing numbers of 'C' type pins, see Table 1. The increasing zinc content of brass is thus a phenomena which is already present in the metal of later medieval period (Werner 1977) prior to its more well known increase due to technical improvements to the cementation process by Nehemiah Champion, in the early 18th century (Pollard 1983).

The change in elemental composition with pin head type, Table 4, is much more marked than that suggested by the data of Table 3. If indeed the alloy change is related to date as suggested by Pollard (1983) and the data of Tables 1 and 4, then it would appear that more marked variations in elemental composition, than are evident in Table 3, did occur but have, in part, been masked probably by contamination of the archaeological contexts with earlier material. These effects of re-

use and residuality will also effect other pin parameters such as pin length. Thus the changes noted in the archaeological data may have been far more marked in practice.

The Nature of the Pin Industry Suggested by the Different Forms of Evidence.

This study has shown that the written history of the pin industry suggests that it undergoes some extremely turbulent changes from its hand crafted origins, through its dramatic expansion in the 14th and 15th century, with its demise in the 16th and 17th centuries under the onslaught of cheap continental imports to a phase of mechanisation and a resurgence in the 18th century, finally to be seen as the prime example of a product manufactured with the specialised division of labour (Smith 1776).

When examined in 'archaeological' terms no such 'turbulence' is evident, indeed compared to the dramatic product changes in the weapons, fashion and ceramic industries of this period, there is very little product change in the pin industry. Though there are changes in the pinhead form and metric parameters of the pin, which do indeed correspond to those likely to be seen as a result of increasing mechanisation, all changes observed appear slow and gradual.

The apparently slow nature of this change may have occurred in reality or may appear to be drawn out over time due to the problems of dating archaeological contexts, the problems of residuality and prolonged object use, as well as the problems of obtaining large enough samples for statistical certainty. These problems clearly plague any archaeological product based interpretation of an industry. We need to document accurately a number of known product changes in an archaeological manner before we can quantify the blurring effect of recovery via the archaeological process.

The picture of slow and gradual change is echoed by the variations in the elemental composition of the metal. The range of copper alloys used to manufacture pins was identical to that generally used for the manufacture of wire, which was in turn very similar to that used for wrought and sheet copper alloy manufactures. Any restriction in composition was due to the selection of alloys which would draw successfully into wires, ie they had little or no tin and or lead present. Pins cannot, therefore, be seen as a specialised product requiring a particular alloy. Few exterior influences appear to have been significant enough to cause compositional change in the copper alloy metal supply of 14th to 19th century Europe. The changes which are observed such as the increasing zinc content of brass and reduction in the level of tin, reflect the very general changes in the overall copper alloy composition of this period (Cameron 1974; Werner 1977; Caple 1986). The same problem factors of date and contextual purity as noted with typological and metrical change, also affect the metal composition data tending to obscure the effect of change.

This study has shown that a seemingly ubiquitous product such as pins do change gradually with time. If pins are recovered from secure well dated contexts, analysed carefully in sufficient numbers to be statistically significant, they may prove through their head type, elemental composition and mean length to have some limited potential as an independent dating method.

Given the typological, metrical (Graph 1), and elemental (Caple & Warren 1983) variation seen in an industrially manufactured product which often occurs in specific narrowly dated contexts

(Whitefriars 1548-1558 AD), large groups of data are required in order to an accurate picture of 'real' changes in industrial product over time. This should surely emphasise the caution required in making general interpretations regarding the nature of the industry from craft based manufactured objects. The level of non-significant variation is clearly going to be extremely high.

Without the historical record, our perception of the mediaeval pin industry, based on the head type, metrical and analytical parameters of the object would be very different, presumably one of slow change and gradual development implying social and economic stability. There is clearly great economic and social turbulence in written historical terms behind minor variations in the composition and form of an archaeological industrial product. In this case it is questionable that any product variable can be directly related to a social, political or economic event. This study re-enforces the perception that the written records of history invariably describe change rather than continuity. The picture presented by archaeologically recovered material culture, in this case pins, is one of continuity and stability.

In view of the above points there would be considerable worth in trying to define the nature of other mediaeval industries and their associated product variations. A series of similar studies may allow the formation, through empirical examples, of models of industry which could be applied for earlier non historical industrial products, and which would start to give us a more complete idea of the social and economic disturbances represented by, or consequent upon, industrial product change.

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